ON FACTORS GOVERNING THE DISTRIBUTION OF WILD MAMMALS IN KARNATAKA

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(*With five plates and seven text-figures*)

The forests of Karnataka are largely restricted to hill regions, and depending on the precipitation the forest types range from the evergreen to scrub vegetation. An analysis of food resources available in the various vegetation types shows that the evergreen forests are particularly suited to frugivorous arboreal primates and squirrels, while the deciduous forests offer the best habitat for larger grazing herbivores like the gaur and the deer. Drought resistant ungulates, particularly antelopes are specially adapted to the open dry scrub. The wild life bearing forests areas of Karnataka are divided into six regions, namely North Kanara, Crestline, Malnad, Mysore Plateau, Kollegal Hills and Maidan. Occurrence ratings for the major wild mammals over 86 forest ranges of these six regions have been determined on the basis of field studies. An analysis of this data shows that wild life can be considered abundant only on the Mysore Plateau with Malnad, Kollegal Hills, North Kanara, Crestline and Maidan showing a progressive decline in that order. This decline seems highly correlated with the fragmentation of the habitat; hence it is critical to maintain the integrity of the remaining wild life habitats.

Introduction

With its great diversity of ecological conditions, and its unique position at the confluence of three biogeographical realms, the Indian subcontinent can boast of a diversity of wild life unequalled by any land mass of comparable size in the world. Tragically, the recent decades, particularly since the beginning of the British rule, have witnessed a rapid decimation of our wild life heritage to the point that a large number of species are now on the verge of extinction. The situation obviously calls for serious efforts at conservation, and these have in fact been launched, particularly over the last few years. Very little careful documentation of the status of our wild life, and the problems confronting us in our efforts at its conservation is however available. There are a few general accounts, the most important being those of Prater (1971), Gee (1969) and Krishnan (1975), and a few detailed accounts of specific areas such as those of Schaller (1967) for Kanha, Berwick (1976) for Gir and Nair *et al.* (1977) for the Bandipur-Mudumalai-Nagarhole-Wynaad complex. We also have accounts of a few endangered species such as Daniel and Grubh's (1966) survey of wild buffalo, Davidar's (1978) survey of Nilgiri tahr, Nair and Gadgil's (1978) survey of elephants of Karnataka, and Kurup's (1977) survey of the lion-tailed macaque and

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Nilgiri langur. We however still lack careful documentation of the status of wild life over more extensive areas of the country. The present paper is an attempt to furnish such an account for the state of Karnataka. It is based on field studies extending over a period of four years in various parts of the state. It documents the status of major wild life species in a number of representative forest ranges where wild life still persists. In addition it makes an attempt to bring out the factors governing this distribution. The rainfall pattern over the state, determined by the topography, governs the distribution of natural vegetation. This vegetation has been considerably modified by human interference. The resulting vegetation types differ in the degree of availability of different food resources on which depend the populations of wild mammals. This availability of food resources governs the natural distribution of wild mammalian species, depending on the extent to which the ecological requirements of each species are met by a given vegetation type. This is the distribution of wild mammals that prevailed historically before its decimation in recent times. To understand the present distribution, we must additionally take account of man's deleterious impact in different regions and on different species. This paper is an attempt to present such an account. It is hoped that it will provide a basis of information useful for the future attempts at conservation of wild life in Karnataka.

Materials and methods

This report is based on studies carried out in Karnataka over a period of four years from May 1974—June 1978. We have maintained continuous observations at Bandipur national park over the four years, and fairly extensive observations in North Kanara areas from March 1976 onwards. This has been supplemented by an intensive survey of the Mysore plateau from July to October 1975, a survey of North Kanara areas from August 1976 to January 1977, a survey of the rest of Western Ghats and Malnad areas, and of Kollegal hills from May to July 1977 and a survey of the Ranebennur forest in May 1978. The methods employed in these surveys have been described in detail in our earlier publications, and need not be repeated here (Nair *et al.* 1977, Nair and Gadgil, in press).

These surveys have enabled us to arrive at estimations of the occurrence of major wild mammals in 86 of the forest ranges of Karnataka—which covers substantially all of the forest ranges with significant populations of wild animals. The estimates were based on actual sightings, evidence of droppings, signs of feeding and other spoor and reports from tribals and local field staff. In many places the reports were cross-checked with actual field data and were found to be reasonably accurate. An attempt to arrive at estimates of numbers was made only in the case of elephant populations (Nair & Gadgil, in press). In case of all other mammals the population status was ranked on a five point scale: absent —0, rare—1, present—2, frequent—3, and very common—4. This is admittedly subjective and is essentially a comparative statement, comparing the different ranges for a given species. The population of sambar to be ranked very common will obviously have to be much greater than the population of tiger to be ranked very common! Such qualitative ranking is nevertheless of value in giving a clearer picture of the differences in occurrence in various parts of the state and is adopted here in that spirit. While computing occurrence, we automatically note the presence or

absence. From this we shall derive the measure of frequency which is defined as the percentage of total forest ranges within a given region in which a particular species is present. Thus any region under consideration may be characterized by the occurrence value averaged over the constituent forest ranges and a frequency of incidence value with respect to any particular species.

The habitat of that region was further characterized by the prevalent vegetation type, extent of its degradation particularly in terms of the canopy cover and the major plant associations. In addition, the habitat was characterized with respect to its extent of fragmentation. This index was calculated by taking an average of the following ratio for a number of constituent ranges.

$$\frac{Df - Dn}{Df}$$

where Df = distance between the two farthest villages or cultivation or mining in the range.

Dn = distance between the two nearest villages or cultivation or mining in the range.

The ratio ranges from 0 to 1, increasing with the extent of fragmentation of the forest. Admittedly, this too is a crude measure, but serves to indicate well different levels of fragmentation of the forest in different parts of the state.

Topography

The state of Karnataka lies between latitudes 11°35′ to 18°25′N and longitudes 73°40′ and 78° 40′E with the states of Maharashtra to the north, Andhra Pradesh to the east, Tamilnadu and Kerala to the south and with the Arabian Sea to its west (Figure 1). Geographically it is made up of three distinct regions; karavali or a coastal strip on the west, malnad or the hill region in the middle and maidan or the plains of the Deccan plateau to the east. The coastal strip varies in width from just a few kilometres near Karwar in North Kanara to 50-75 kilometres in parts of South Kanara. This coastal strip is flanked to its east by the hill chain of Western Ghats which runs in a north-south disposition parallel to the west coast. In North Kanara the hills are broken and low with an elevation around 1000 m. South of Bhatkal, however the ghats are continuous and rise to an altitude of 1892 metres in Kudremukh. The ghats rise precipitously to their heights with steep slopes abruptly rising out of the coastal plain. To the east they merge gradually with the Deccan plateau, with a series of hills such as Bababudangiri and Mahadeveshwara Malai rising to considerable heights out of the plateau (Figure 2). The Deccan Plateau is itself an undulating plain at an elevation ranging from 500 to 1000 metres.

Precipitation

This lay of the land governs the pattern of precipitation over the state of Karnataka. The state receives almost all of its rainfall from the southwest monsoon between the months of June and September. This monsoon depends on the moisture laden winds that come from the Arabian Sea. The coastal strip receives annual rains of 3000-4000 mm as these winds come over land. The highest precipitation, however, occurs over the ghats because of the ascent of the air forced by the orography. To the north, where the ghats are low, the precipitation is around 4000-5000 mm, but reaches its maximum of around 8000 mm a year in the Agumbe—Kudremukh region. The rainfall in this region is almost

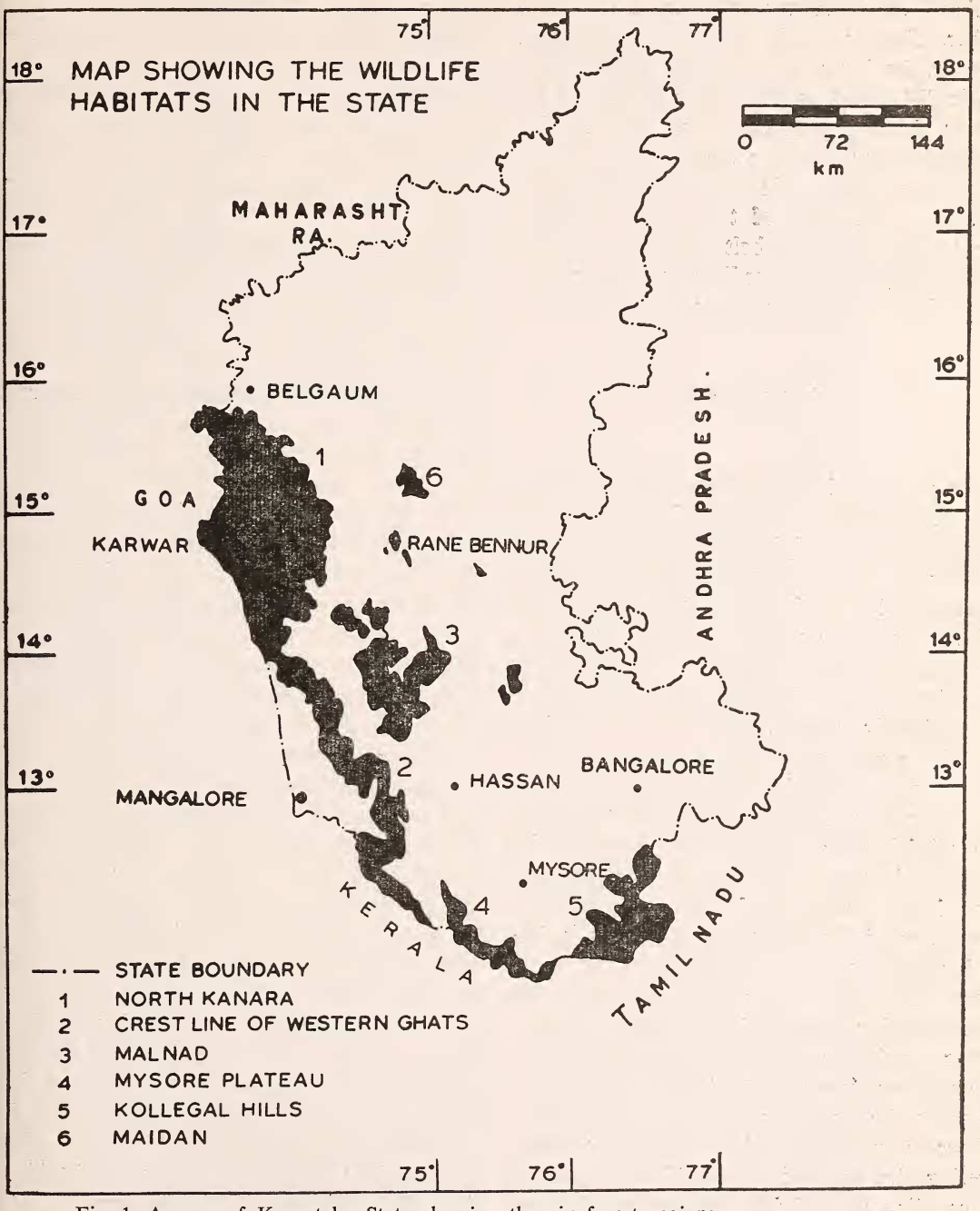


Fig. 1. A map of Karnataka State showing the six forest regions.

restricted to the four months from June-September. Further south in the Coorg region, however, the fairly heavy rainfall of 5000-6000 mm is distributed over a longer period of 7-8 months from April-November. The rainfall decreases sharply to the lee of the ghats on the Deccan plateau. It ranges between 600-1000 mm over most of the Deccan plateau, except in the semi-arid belt stretching over the Gulbarga-Bijapur-Raichur-Bellary region where the rainfall is uniformly below 600 mm a year.

Vegetation

The pattern of natural vegetation over the state of Karnataka is governed essentially by the amount of precipitation, the temperatures reaching a limiting influence only at the higher elevations of the Western Ghats. The coastal plains must in the past have been covered by the mangrove forest near the coast and evergreen forest in the interior plains where rainfall uniformly exceeds 3000 mm. The foot hills of the ghats must also have been covered by evergreen forest in earlier times. The current occurrence of semi-evergreen forest in this high rainfall zone (>3000 mm) seems to be a result of human intervention; the degradation of the evergreen forest has permitted penetration of deciduous tree species in it, imparting semi-evergreen character to the vegetation. The upper slopes and crestline of the ghats receiving precipitation of over 5000 mm a year would have been covered everywhere by evergreen forests. At higher elevations in the ghats the evergreen forest is restricted to hollows as evergreen sholas, with grassy downs covering the exposed slopes. To the east of the crestline the rainfall decreases again, and would support a belt of semievergreen forest in the zone of 2500-3000 mm. The forest would assume a deciduous character further east where the rainfall falls below 2500 mm. The forest would be of the moist deciduous type over a broad belt where the rainfall ranges from 2500-1500 mm a year. Much of the Deccan plateau would under the natural state be covered by a dry deciduous forest, except for the semi-arid tracts with rainfall below 600 mm. These tracts would be covered by a scrub forest (figure 2) (Champion & Seth 1968, Legris 1963, Meher-Homji personal communication).

This pattern of vegetation has been drastically changed by human activity over most of the state of Karnataka. The mangrove forest has entirely disappeared from the coast, and so has the evergreen forest of the coastal plains, to be replaced by paddy and coconut cultivation. The dry deciduous and scrub forests of the maidan area have also disappeared almost entirely, to be replaced largely by cereal crops. The Western Ghats and the adjoining hill tracts, however, still retain some of their forest cover, wherever it has not yet been replaced by plantation crops or other cultivation. This has been heavily exploited by man, generally resulting in the disappearance of evergreen elements from many forests which would originally have been dominated by them. The canopy has been opened everywhere, allowing the forest floor to be invaded by exotic weed species. Wherever rainfall exceeds 1500 mm, the opening of the canopy leads to an invasion by *Eupatorium;* in the dry deciduous forests, the weed species to dominate the vegetation belong to genus *Lantana.* In the drier tracts, exploitation of deciduous forest has often reduced it to the status of a scrub, if not to secondary grassland. In the semi-arid regions the scrub has all but disappeared giving way to a very poor secondary grassland.

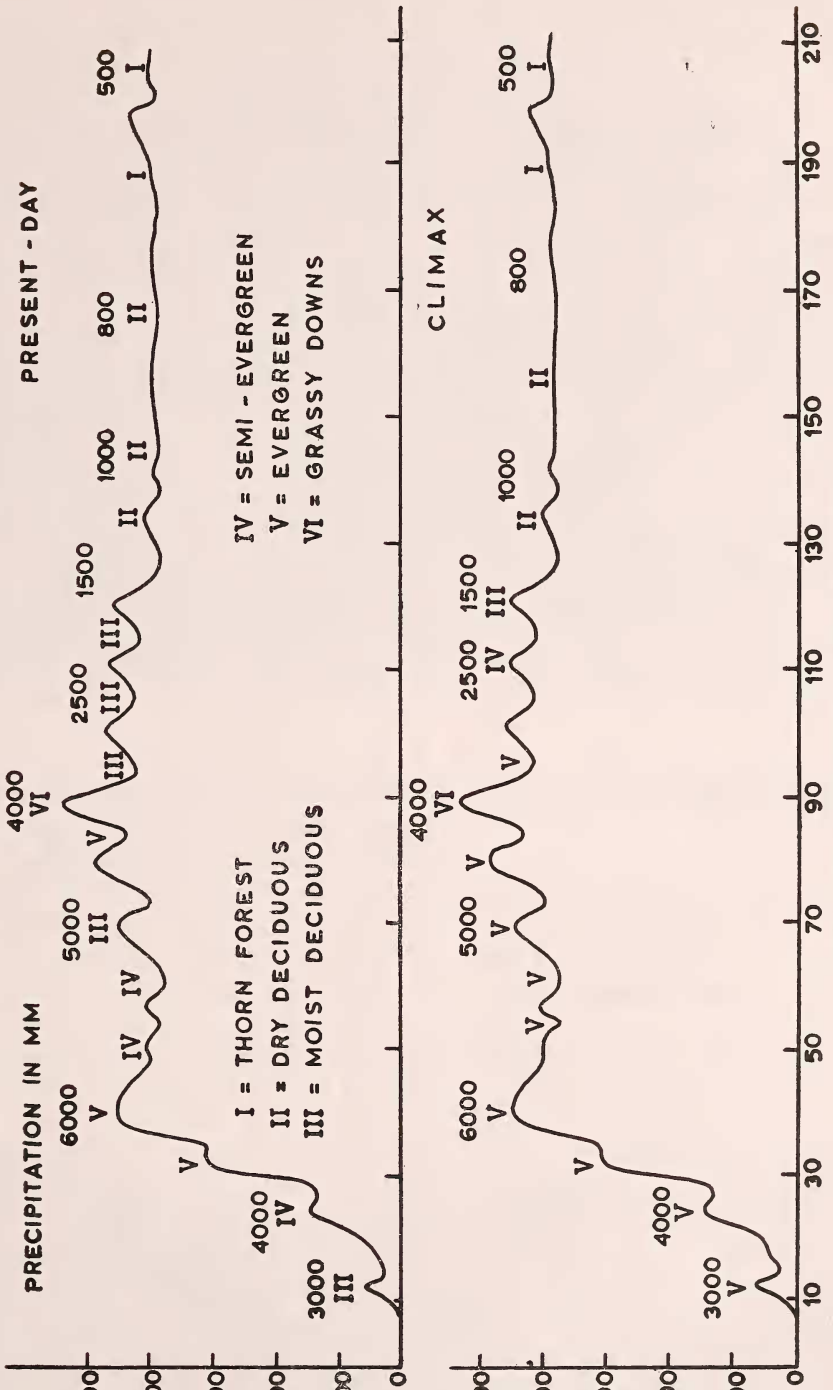


Fig. 2. A schematic cross-section of the Karnataka region indicating the topography, precipitation and climax and present day forest vegetation.

Food resources and distribution of mammals

The natural distribution of mammals is ultimately governed by the natural distribution of the vegetation. As heterotrophs, the mammals are dependent on the primary production of the organic matter by the plants. The productivity of the mammalian fauna of any habitat would therefore be related to the productivity of the vegetation. In addition, the composition of the mammalian fauna would depend critically on the specific form in which the plant production is channelised. Thus grazing herbivores would not be able to sustain themselves in an evergreen forest with almost no growth of grass on the forest floor. Frugivores dependent on fleshy fruits would, on the other hand, find abundant food in an evergreen forest. It is therefore most instructive to compare the three major natural vegetation types of Karnataka with respect to the different components of plant production, as well as the production of insects, frogs and lizards.

Evergreen Forest

Table 1 contrasts the distribution of food resources in the pure evergreen, the evergreen shola-grassy downs, deciduous and scrub vegetation in its original climax condition as well as in the degraded form of evergreen, deciduous and scrub vegetation. The degradation is assumed to be to the level at which the canopy is considerably opened but without loss of the basic nature of the forest. The climax evergreen forest has a complete canopy and a fully shaded forest floor covered with leaf litter with no grass and very little other herb growth (See plate 1). Its canopy is at a considerable height from the ground. In consequence there is very little grazing or browsing for ungulates or elephants in such a forest. Bamboos, a favourite food of these animals is also nearly absent from the evergreen forests. The few herbs on the floor belonging to families like Zingiberaceae all tend to have underground storage organs like corms or tubers which are therefore available to the diggers like pigs though the leaves of these herbs are by and large unpalatable. The plant production available to the herbivores in such forests is therefore the tree foliage at the high canopy level and fleshy fruits such as jackfruit, mango and jamun which are so characteristic of evergreen vegetation. Dry fruit and seed are also relatively uncommon. The rich leaf litter on the ground which supports a high level of arthropod fauna, and the prevalent high humidity however supports a very rich amphibian and reptilian fauna in the climax evergreen forests.

An idea of the herbivore and omnivore fauna that such a climax evergreen forest can support can be had from Tables 2 and 3. Table 2 lists the major components of food of the herbivorous and omnivorous mammals of peninsular India. A comparison with the availability of these components in Table 1 allows us to deduce the capacity of the different vegetation types to support these mammals. (Green & Minkowski 1977, Krishnan 1975, Prater 1971, Schaller 1967). It is evident that evergreen forests are particularly rich in the food for arboreal monkeys and squirrels which can feed on fruit and leaves and insects and small vertebrates high up in the canopy. The evergreen forests may also support wild pigs and sloth bear which are omnivores capable of digging up underground corms and tubers. The climax evergreen forests are however a poor habitat for larger herbivores which find little to feed on the floor.

When, however, such forest is somewhat degraded and openings are created in the ca-

Above: A view of the evergreen forest from the Crestline region. (Photo: *H. C. Sharatchandra*).
Below : A view of the evergreen sholas and grassy downs of Kudremukh from the Crestline region. (Photo: *S. N. Prasad*).

Above: A view of the dry deciduous forest in Bandipur Tiger Reserve, Mysore Plateau. (Photo: *S. N. Prasad*).
Below: The composite weed *Eupatorium* which has invaded the moister forested regions, Mysore Plateau. (Photo: *H. C. Sharatchandra*).

nopy, palatable herbage can grow on the floor of the forest. The much larger younger crop of saplings produced would also provide browsing. Such degraded forest does therefore become a better habitat for larger mammalian herbivores.

Sholas and Downs

The higher reaches of the Western Ghats are characterized by a juxtaposition of evergreen sholas lying in the hollows and grassy downs on the more exposed slopes. These grassy downs offer rich grazing grounds for the larger mammals, while the evergreen sholas provide them good shelter. The combination therefore affords an ideal habitat for a rich variety of mammalian species (See Plate 1).

Deciduous Forests

The deciduous forests offer a much more balanced picture of the availability of food resources for the mammalian species. In such vegetation, the total amount of tree foliage and fleshy fruits will be less than in the evergreen forests, rendering it a somewhat less suitable habitat for frugivorous monkeys and squirrels. At the same time, the more open canopy will allow growth of grass and other palatable herbage and shrubbery on the forest floor, as well as a rich growth of bamboos rendering it a much more suitable habitat for the larger herbivores such as deer, gaur and elephant (See Plate 2). Moderate degradation of such forest further encourages the growth of grass and bamboo, improving it as a habitat for larger mammals. As will be noted from Tables 1, 2 and 3, the deciduous forests are an excellent habitat for a wide spectrum of mammals.

This is not to imply that indefinite degradation of deciduous forests will progressively improve them as wild life habitats. Such forests are quickly invaded by *Lantana* and *Eupatorium*, the former favouring dry deciduous and the latter moist deciduous habitats. *Lantana* though largely unpalatable to wild mammals, does provide fresh leaves, flowers and berries which are consumed. The berries are a favourite food of birds as well. *Eupatorium*, on the other hand, has no redeeming features. It carpets vast stretches of forest floor, smothering out all regeneration, posing a fire hazard, and is absolutely unpalatable to wild animals who never touch it (See Plate 2).

Scrub Forests

The scrub forest in its climax condition is overall a less productive habitat than the degraded deciduous forest. The *Acacias* which dominate it are nevertheless a good source of palatable leaves and pods for many browsing herbivores, particularly elephants. Under its natural condition, the scrub forest can therefore support a rich mammalian fauna as indicated in Tables 1, 2 and 3. An important limiting factor in these forests is water. Since antelopes such as blackbuck and nilgai are much more tolerant of drought than deer and gaur they tend to dominate the community of grazing herbivores in such habitats.

A degraded scrub is reduced to a secondary grassland of very poor productivity (See Plate 3). Such habitat can essentially support only blackbuck and chinkara and smaller mammals such as hares.

Carnivores

Table 4 summarizes the expected pattern of natural abundance of carnivores in different vegetation types. Stalking predators such as tiger and panther require a good population of larger mammals plus good cover. They are therefore at their best in deciduous forests. Cheetah which depends on speed for pursuit requires more open country and was once com-

mon in scrub forests of India but is now extinct. The wild dogs and wolves depend on their stamina, teamwork and speed to run down their quarry. The former seems more adapted to forest habitat and the latter to open scrub.

Tables 3 and 4 thus summarize the pattern of distribution of wild mammals that should prevail in peninsular India in the absence of a serious persecution of these animals at the hand of man. Some species, such as elephant and wild pig would be rather widely distributed, while others such as lion-tailed macaque would be much more restricted in their distribution. Nevertheless there would be an overall high abundance of wild mammals throughout the variety of wild habitats. This supposition is supported by the available historical evidence, particularly recorded in the early gazetteers. (Nicholson 1887, Stuart 1895, Francis 1904, Anonymous 1908). No more than a century ago, a variety of wild mammals occurred commonly throughout much of the state of Karnataka largely conforming to the pattern indicated in Tables 3 and 4.

There were of course tracts which had been under intensive cultivation for a long time, and from which wild mammals were largely excluded. Such, for example must have been the case with paddy lands in the coastal plains of South Kanara. There were however still vast tracts of lands under natural vegetation, and with large mammalian populations till a century ago, their abundance essentially governed by the availability of resources required by each of the various species in different types of natural vegetation. The last century in particular has seen rapid changes and overall drastic decline in the populations of wild mammals of Karnataka due to mounting pressures of persecution by man.

Human persecution

The degree to which the persecution by man has affected the mammalian fauna has varied considerably in different habitats and for different species depending on a variety of factors. These factors include (1) accessibility of wild life habitats to man (2) ease of hunting a species (3) reproductive resiliency of the species (4) religious protection enjoyed by a species (5) commercial demand for trophy, presumed medicinal value etc. (6) conflicts with human interests because of crop raiding, killing of livestock etc. (7) extent of demand for the habitat of wild animals such as for mining.

It may be worthwhile reviewing the effect of human persecution on the twentytwo major wild mammals of Karnataka listed in Tables 3 and 4. The lion-tailed macaque has always been restricted to a few pockets of evergreen vegetation. Its habitat is rapidly diminishing and degrading, and this rare, essentially frugivorous, primate is an endangered species. The bonnet macaque enjoys wide religious protection and still lives in large populations throughout the state in forests, scrub as well as in cultivated tracts. The hanuman langur is a more specialized leaf eating monkey, and has a more restricted distribution than the omnivorous bonnet macaque. It also enjoys religious protection and lives in good numbers in deciduous forest tracts. The giant squirrel is essentially restricted to evergreen, semi-evergreen and moist deciduous forests where it occurs in good numbers.

The elephant populations have suffered drastically through loss and fragmentation of habitat, persecution for ivory and killing for crop protection. A good population nevertheless exists in the Bandipur-Nagarhole complex (Nair and Gadgil, in press). Gaur are still widely distributed, particularly in deciduous forests,

Above: A view of the scrub forest in the Kollegal Hills Region.
Below: Cultivation in the midst of forest, Haliyal Division in North Kanara region. (Photos: *P. V. K. Nair*).

Above: An elephant herd in Bandipur Tiger Reserve.
Below: A tiger in Bandipur Tiger Reserve. (Photos: *A. J. T. Johnsingh*).

though much reduced in numbers due to poaching for meat and hide. Sambar very much follow the pattern of gaur. Chital are restricted to more open degraded deciduous forests, where they survive in good numbers where protected. Barking deer, a solitary species with wide habitat tolerance is much hunted for meat and survives in thin populations.

Blackbuck, chinkara, nilgai, wolves and cheetah once inhabited the open scrub forests in large numbers. Living in accessible plains, easily hunted in their open habitat, they have been the main victims of persecution at the hand of man. Cheetah has become totally extinct and the others have nearly disappeared too, surviving only in small pockets where they are given special protection.

Blacknaped hare, wild pig and jackal are the only three species still surviving in good numbers. This is due to their ability to take advantage of man-made habitats and cultivation, and their great reproductive resilience. All three breed in sheltered places and produce moderate to large litters. This has enabled them to minimise persecution, and to rapidly build up their populations in face of persecution.

Porcupine, a solitary nocturnal animal is hunted for meat with the help of dogs who locate their burrows. It nevertheless survives in scattered populations. The omnivorous sloth bear, a denizen of evergreen—deciduous forests, is not particularly persecuted, and probably survives in scattered populations.

Of the carnivores, tiger, panther and wild dog are all much persecuted, the first two for their valuable pelt and to avenge cattle kills, and the third rather wantonly, even by the official foresters as a competitor for herbivores with man. The first two have declined drastically, while the wild dog seems to be holding its own much better.

Present status

The area under forest in Karnataka today amounts to 28846 sq. kms, a mere 15.04% of the total land area of the state. With the notable exception of the bonnet macaque, which under the widespread religious protection ranges throughout the state, the larger wild mammals are entirely confined to the forest areas. These forest areas, may, for our purpose be divided into six different regions, each of which is largely contiguous and has distinctive ecological features. For convenience, we have named these six wildlife regions: North Kanara, Crestline, Malnad, Mysore Plateau, Kollegal Hills and Maidan (Fig. 1) (Nair & Gadgil, in press).

North Kanara

The district of North Kanara and parts of Belgaum constitute the northernmost sector of hill tracts of Karnataka (latitude 13°45′N to 15°45′N, longitude 75°0′ E to 75°15′ E). The hills are low, but form a rather wide belt. The precipitation varies from 6500 mm at the crest to about 1000 mm on the plateau, and the vegetation consequently ranges from evergreen, semi-evergreen, moist deciduous to dry deciduous types. The proportion of deciduous forest computed as the proportion of forest ranges predominantly deciduous in nature, is 0.52. At one time, over 80% of this region was under forest cover. It has been, however, considerably disturbed in recent years with rapidly multiplying human settlements, heavy exploitation of forest for timber and softwoods and bamboo, manganese and iron mining, and above-all the giant Kalinadi hydel project. Consequently, the habitat is now very much fragmented, with the index of habitat fragmentation at a high value of 0.92 (See Plate 3).

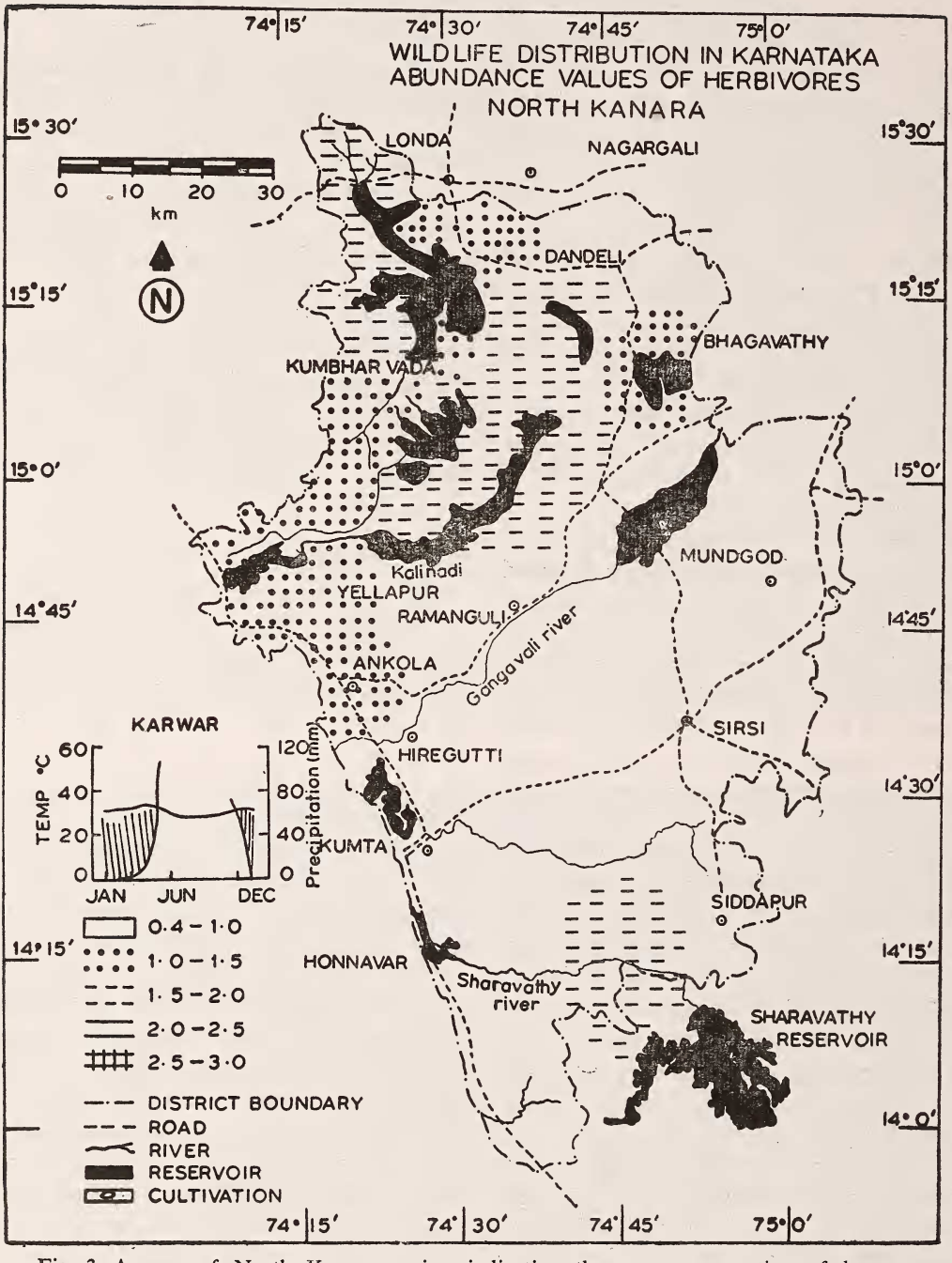


Fig. 3. A map of North Kanara region indicating the occurrence rating of larger mammalian herbivores.

Table 7 lists the occurrence rating for 8 of the major wild mammals of this region over 26 ranges. The data are further summarised in tables 5 and 6 and figure 3. There are today only five small herds of elephants over this vast forested region, scattered in the semi-evergreen and moist deciduous tracts. They cover two-thirds of the ranges of the region. The frequency of incidence of gaur is similar, and it also occurs in small scattered herds with larger herds surviving only in parts of Haliyal division. Sambar is much more widely distributed, occurring in 85% of the ranges, barring the heavier rainfall areas. It also receives a little better occurrence ranking. The spotted deer occurs in little over half the ranges and is in low abundance. This thick, moist forest is obviously a poor habitat for it. The wild pig occurs over almost all ranges and is the most abundant of wild mammals. Its tolerance of a wide range of vegetation types, its penchant for crop raiding, and its high reproductive rate are the reasons for its greater success. Evergreen forests of North Kanara harbour some populations of lion-tailed macaque in the Siddapur Range. The hanuman langur is commonly found particularly in the semi-evergreen and moist deciduous tracts. The carnivores, tiger, panther and wild dog all occur in rather low populations but are distributed over many of the ranges. They are commoner in the dry deciduous ranges of Katur, Mundgod and Kirwatti, and quite uncommon in the evergreen forest.

The great forests of North Kanara are a little too dominated by evergreen and semi-evergreen types to be an optimal habitat for larger wild mammals. However, its deciduous forests too are very extensive and rich in bamboo—a prime fodder for large herbivores. The very high frequencies of incidence coupled with the low abundances suggest that the wild mammal populations have been decimated everywhere through human persecution. The high value of habitat fragmentation bears out this supposition of rather extensive human influence on the wild life.

Crestline

To the south of North Kanara, the Western Ghats rise much higher, and narrower. The rainfall in this region is very heavy reaching 6000 - 7000 mm. There is a rather narrow belt of forests following this crestline of the ghats (latitude 11°30′ N to 14°0′ N, longitude 74°15′ E to 76°30′ E). The vegetation is evergreen on the steep slopes west of the crestline. There is a belt of semi-evergreen and moist deciduous forests at the foothills on the west, as well as on the eastern slopes. The proportion of deciduous forests is 0.27, and the fragmentation index is 0.57.

Table 7 lists the occurrence rating for wild animals in 21 of the forest ranges of this region, while tables 5 and 6 and figure 4 summarise the data. As may be seen from these, the wild mammal populations are on the whole very poor, although most of the major species do occur in this region. Only a few isolated herds of elephants are found in these evergreen forests, and even these have perhaps been forced out by the deforestation of the deciduous tracts to the east of the crestline. The gaur and sambar have high frequencies of incidence (85% each), but occur commonly only on the foot hills of Coondapur. The spotted deer occurs only very sporadically and in low numbers. The wild pig, however, is present in all ranges, and is often quite common. Again its adaptibility to evergreen forests, to crop raiding, and its high reproductive rate render it the most successful of larger wild mammals. The lion-tailed macaque occurs in the evergreen forests of Sagar.

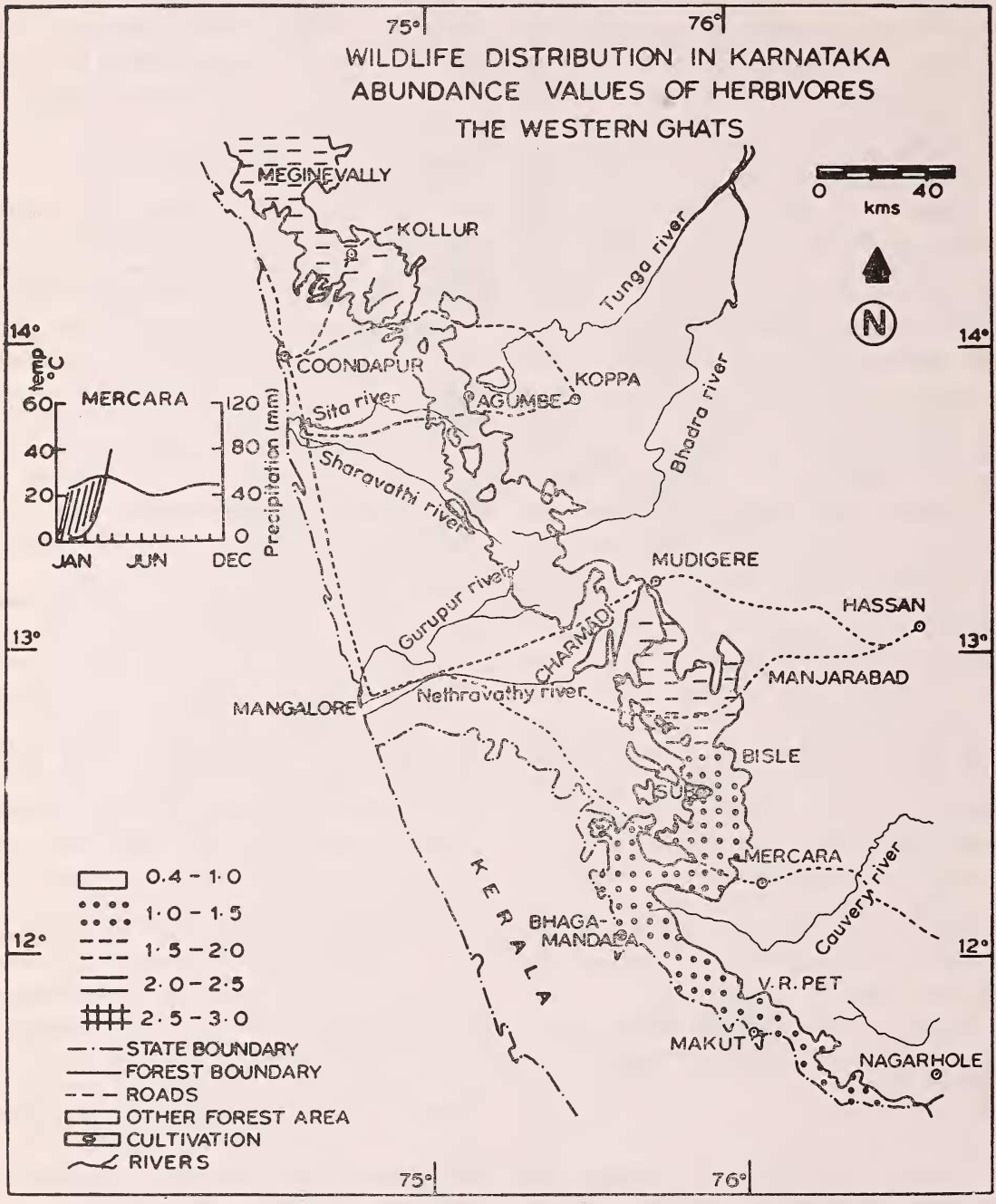


Fig. 4. A map of Crestline region indicating the occurrence rating of large mammalian herbivores.

The hanuman langur is present as well. The carnivores, tiger, panther and wild dog are all present, but their occurrence rating is low in conformity with the low occurrence rating of their prey.

Only a small proportion, 0.27, of the surviving forests in the region of the crestline are deciduous. As discussed above, this implies a poor habitat for most large herbivores, and consequently for carnivores. This is probably an important factor in the very low occurrence ratings of all the major mammals except the wild pig. At the same time, the evergreen forests provide the habitat for a most interesting primate—the lion-tailed macaque. There are in this region some tracts of interspersion of evergreen sholas and grassy downs which provide excellent habitats for many mammals such as gaur and sambar. The low abundances must then also relate to considerable human persecution. This is the case, even though the fragmentation index is relatively low, because the forests occur in a rather narrow linear strip.

Malnad

This region lies to the east of the crestline, seperated by a wide belt of coffee and cultivation (13° 0′ N to 14° 15′ N lat. and 75° 0′ E to 76° 0′ E long.). The area, albeit rather plain, owes its forest cover to several large hills like the Shankar hills and the Bababudangiris rising out of the plains. The rainfall is around 1000 mm, and there are extensive tracts of dry and moist deciduous forest. The proportion of deciduous forests is 0.64, and the fragmentation of the habitat is on the low side, the index taking a value of 0.64.

We have estimates of occurrence ratings of major mammalian species in 14 of the forest ranges of Malnad region; and it is evident that this region boasts of wild life populations only second to Mysore plateau (Tables 5,6 and fig. 5). Almost all of the ranges support elephant populations with a rather large herd of 30-40 living by the Bhadra reservoir. The gaur also occur extensively, being present over 76% of the ranges. The sambar is present in almost all the ranges, as is spotted deer which finds its optimum habitat in the rather degraded deciduous forests of this region. Wild pig, as in other regions is ubiquitous. There are no lion-tailed macaques in the absence of habitable evergreen tracts which are all taken up by coffee plantations, but the hanuman langur is common throughout. The wild dog, panther and tiger are present over most of the region, and their overall occurrence is also high in concert with the higher populations of herbivores.

Overall, the Malnad region, with its opened up deciduous forests is potentially an outstanding wild life habitat. The tracts of forest in this region are extensive with relatively little human interference in the deeper forests. The extensive coffee plantations, heavy exploitation of the forest by forest-based industries, particularly the paper mills, and the disturbance caused by the construction of Tunga and Bhadra reservoirs have however largely decimated the wild life populations which today are a pale shadow of their former self.

Mysore Plateau

The western edge of the Mysore Plateau, flanked on three sides by the southernmost ranges of Sahyadris proper, Nilgiris and the eastern spur of hills towards Biligirirangans is an undulating plain with a rainfall between 600 to 1000 mm a year (lat. 11°35′N and 12° 45′N and long. 75° 54′ E and 77° 0′ E). The plateau is covered by moist and dry deciduous

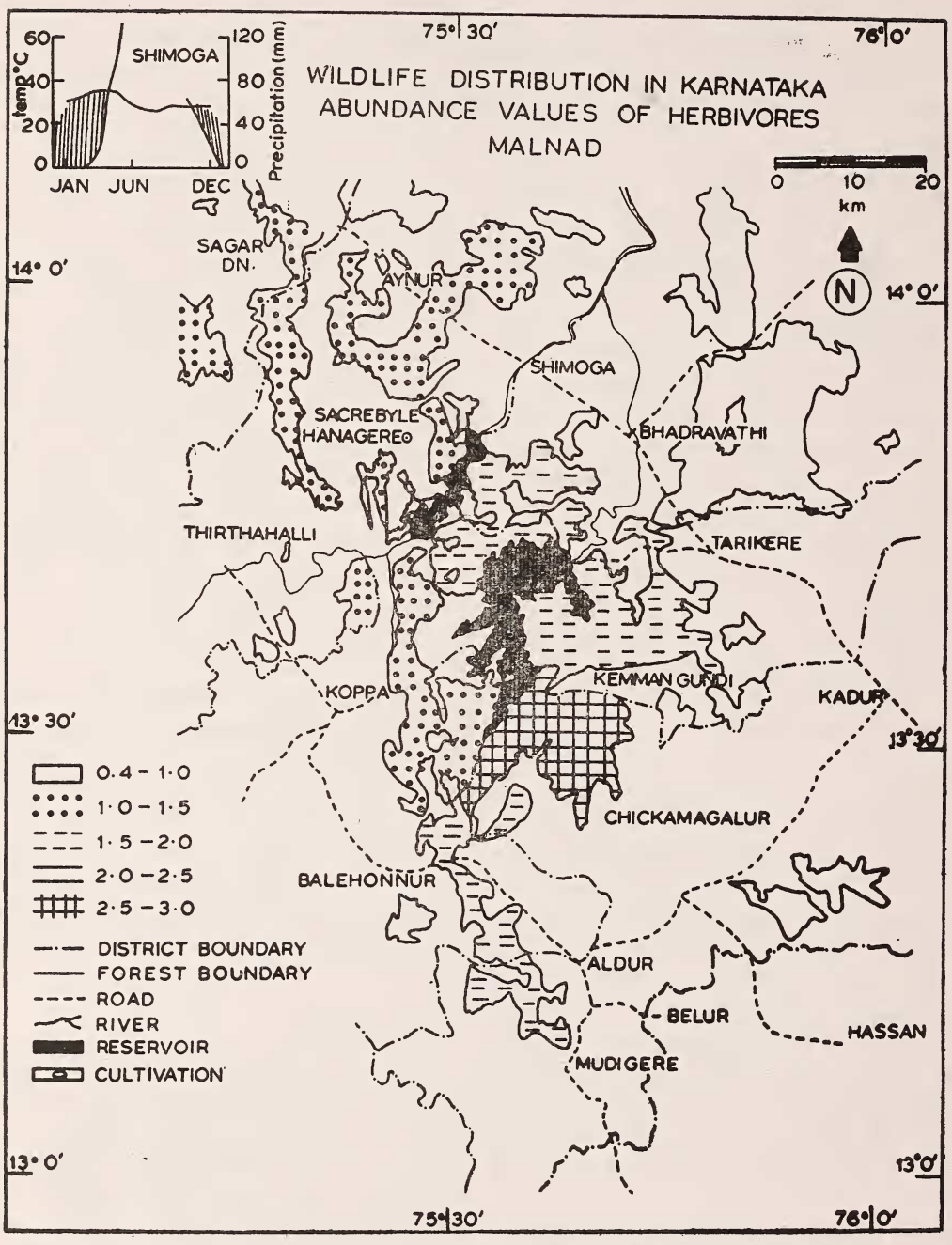


Fig. 5. A map of the Malnad region indicating the occurrence rating of larger mammalian herbivores.

forests, the proportion of the deciduous forests being 1. The forest still maintains much of its integrity though now split into two by the Kabini reservoir, and the fragmentations index of 0.70 is relatively low.

This is undoubtedly the richest wild life region in the state and has been the subject of an earlier detailed report by us (Nair *et al.* 1977). Table 7 lists the occurrence rating for mammals for 13 forest ranges falling within this region, and Tables 5 and 6 and Fig. 6 summarize the data. It is the only region where certain wild mammals can still be considered to be abundant, albeit locally. It has an elephant population of about 1300 animals, a gaur population which was very high till a rinderpest outbreak in 1968, a sambar and a chital population very good in pockets, a good wild pig population, and a good population of hanuman langur. The carnivores too are reasonably common, particularly wild dogs. Panthers and tigers also survive in reasonable numbers (See Plates 4 and 5).

The richness of this wild mammal fauna depends on the eminent suitability of the habitat, which is entirely somewhat degraded deciduous forest, and the protection from persecution over much of the region first as a hunting preserve of Mysore maharaja and then as wild life sanctuaries.

Kollegal Hills

This hilly area, lying between 11° 30′ and 13° 0′N latitude and 77° 15′ and 77° 45′ E longitude is an eastern spur of the ghats. The rainfall is low, around 500 mm except on the Biligirirangan hills where it exceeds 1000 mm. Apart from the moist deciduous, or semi-evergreen forest on these hills, the rest of the region is covered by dry deciduous forest, mostly degraded into scrub. The proximity of the urban centre of Bangalore has been a major factor in hastening the pace of degradation of these forests. Because of this degradation, the proportion of deciduous forests is low—only 0.4, and the forests are highly fragmented, with a fragmentation index of 0.71.

Table 7 presents larger wild mammal occurrence ratings for 10 ranges of this region (See figure 7). Elephants occur over most of this region, and this highly adaptable species still maintains a good population in this and the adjacent Satyamangalam forests. The gaur is restricted to areas where the forest remains at the dry deciduous stage. Spotted deer, sambar and wild pig occur throughout all the ranges. The opened deciduous forest is of course a good habitat for the deer, but the persistence o fthe pig from evergreen to scrub speaks for its versatility. The wild dogs have a fairly extensive distribution, though panther and tiger are much more restricted.

Earlier accounts indicate that this was once a quite rich wild life area in spite of the dryness of the climatic regime. The current rather low occurrence ratings are due to further degradation of the vegetation, and persecution by man in this highly fragmented habitat.

Maidan

Most of the forests of Karnataka, as mentioned earlier, clothe the hills of the Western Ghats, or the adjoining hills in Chickmagalur —Shimoga and Kollegal regions. There is very little forest on the remaining maidan areas on the Deccan Plateau, and what there is of such forest is highly degraded, fragmented and practically devoid of any wild mammals. The proportion of deciduous forest in this region is 0 while the fragmentation index takes the value of 1.

One single range in this region, that of Ranebennur is however notable for the occurrence of good herds of blackbuck, and re-

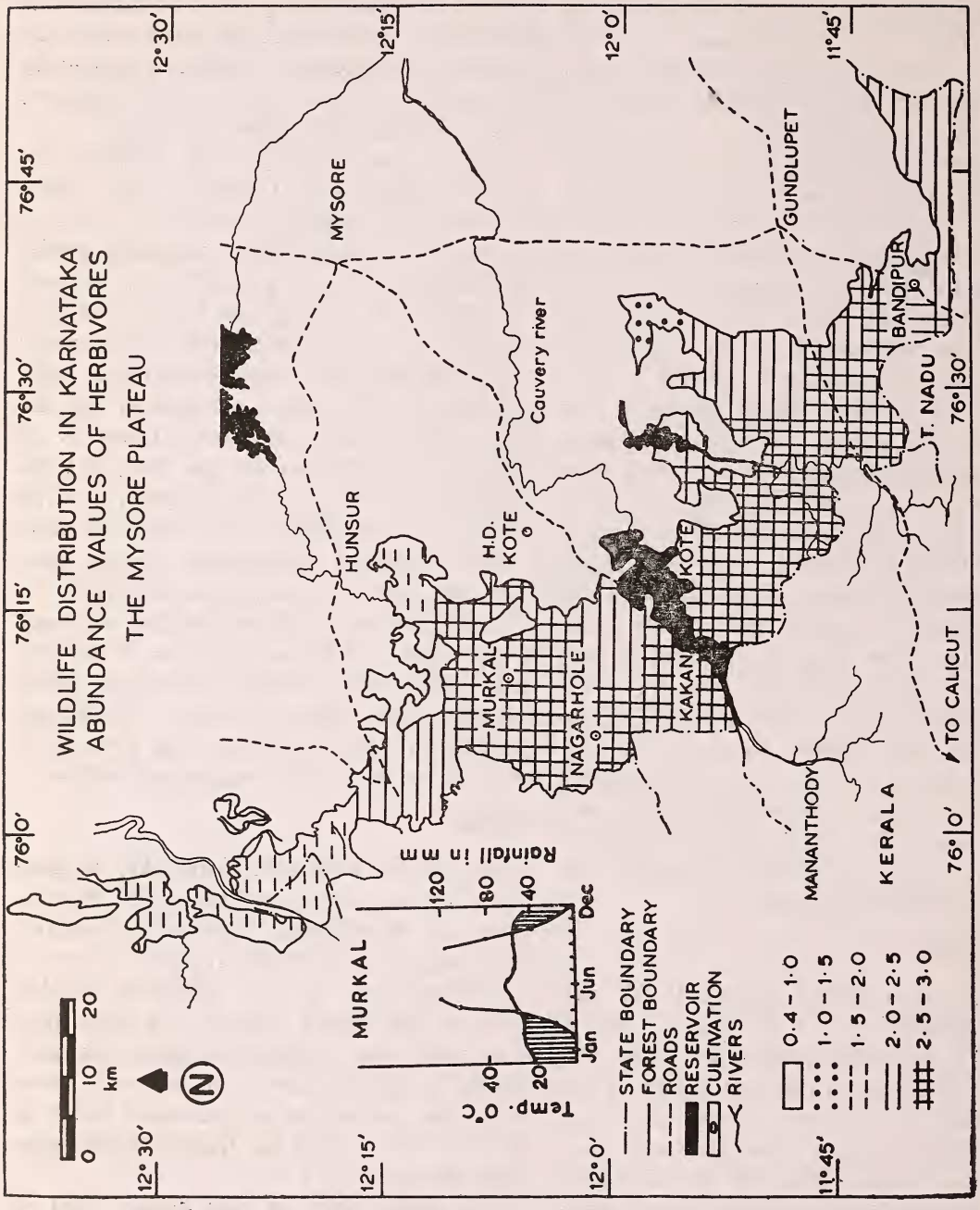
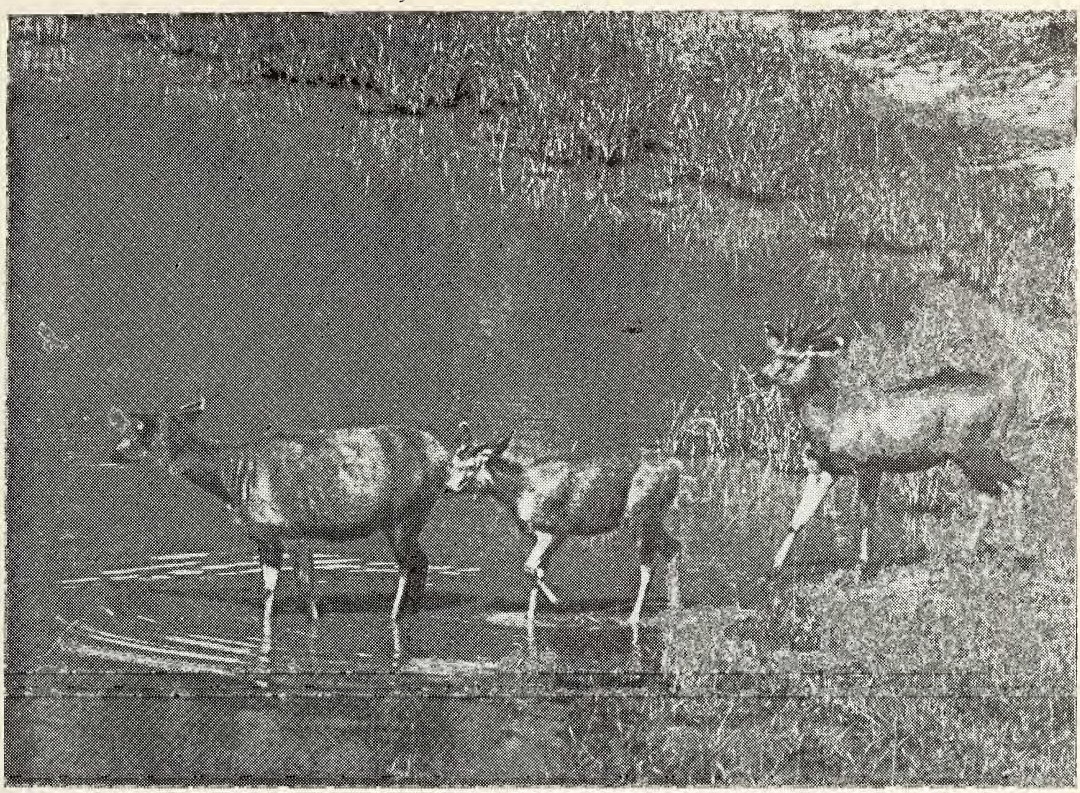
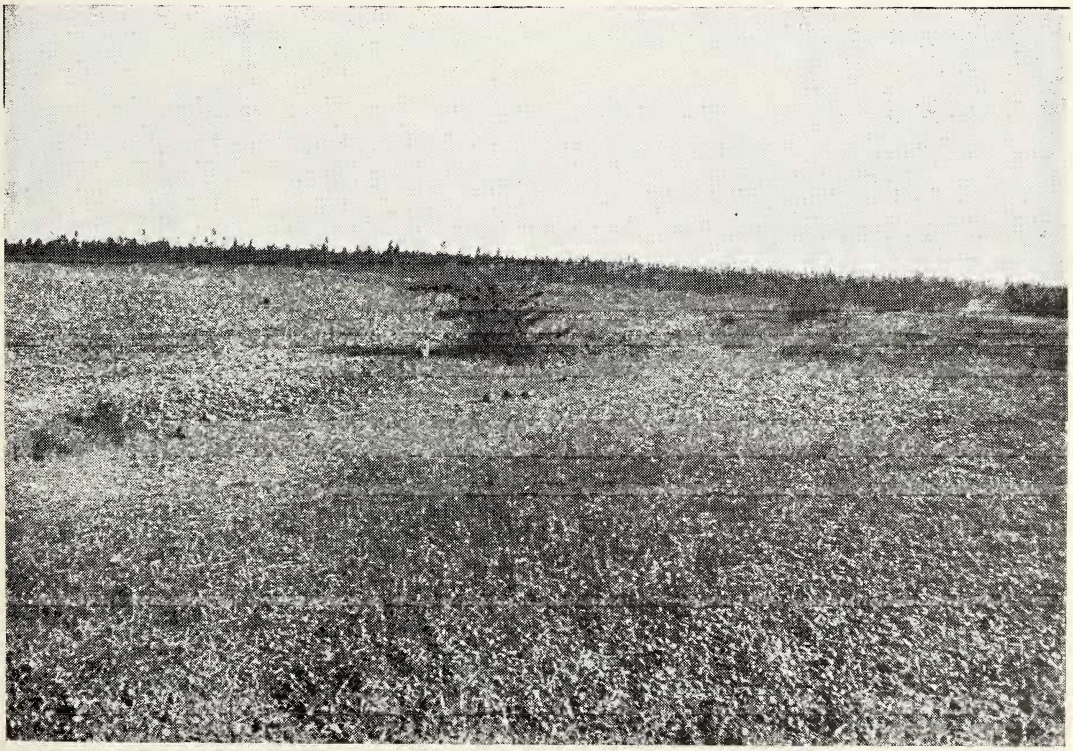


Fig. 6. A map of the Mysore plateau indicating the occurrence rating of larger mammalian herbivores.





Above: Sambar in Bandipur Tiger Reserve. (Photo: *A. J. T. Johnsingh*).
Below: A view of the Ranebennur plains with *Eucalyptus* plantations in the background. (Photo: *S. N. Prasad*).

portedly a few wolves in the Ranebennur sanctuary. This herd apparently built up from a few blackbuck which received protection when a *Eucalyptus* plantation was started in the degraded forest of this range (Neginhal, in press) (See plate 5). Such scattered remnants of blackbuck also apparently occur in other areas such as Raichur.

Much of this dry and open country once supported good populations of antelopes—blackbuck, chinkara and nilgai which have vanished because of the ease of hunting in the habitats of these animals. As stressed earlier, this fauna of open scrubby plains has suffered the worst at the hand of man, with cheetah extinct, and wolf and blackbuck threatened with extinction.

Conclusion

It is perhaps worth commenting on a few of the significant points which emerge out of this analysis. The maintenance of the integrity of the habitat is critical to all our attempts at nature conservation. The great decimation of wild life in North Kanara in particular is largely due to the extreme fragmentation of this great forest, and a similar phenomenon repeats itself in other regions of the state. Apart from this immediately evident effect, much evidence is now accumulating from a number of ecological studies to show that small, fragmented habitats cannot in the long run sustain their original biological diversity, though they may continue to do so in the short run. It is therefore being stressed that maintenance of large contiguous areas should be a very important aim of all efforts at designing nature reserves (Diamond 1975). We must therefore strive to avoid any further fragmentation of the wild life habitats, particularly in the few viable areas such as the Bandipur—Nagarhole complex which still remain with us.

The second point that emerges is that the situation is far worse in respect of the conservation of the fauna of the evergreen forests and scrub when compared with that of the fauna of the deciduous forest. As investigations of Dr. Pascal and his colleagues from the French Institute have shown, very little now remains of the once extensive evergreen forests on the Western Ghats of Karnataka. The one larger mammal—the lion-tailed macaque—characteristic of the evergreen forests of South India is thereby threatened with extinction. Much more importantly, a large number of amphibians and reptiles which are also unique to this ecosystem are no doubt likewise disappearing, although this is hardly realised because of our near-total ignorance of this fauna.

As emphasized above, the fauna of the open scrub has been decimated to a much greater degree than that of the thicker forests, and there is an urgency to step up efforts to conserve and replenish it. There are no sanctuaries representing this type of ecosystem in Karnataka, except for Ranebennur. Ranebennur is however a *Eucalyptus* plantation and as Neginhal (in press) has shown, is fast losing its ability to sustain the blackbuck population. It is imperative that a genuine scrub vegetation be built up, its typical wild life restocked and the ecosystem restored in some reasonably large wild life sanctuary in the semi-arid belt of the Deccan plateau.

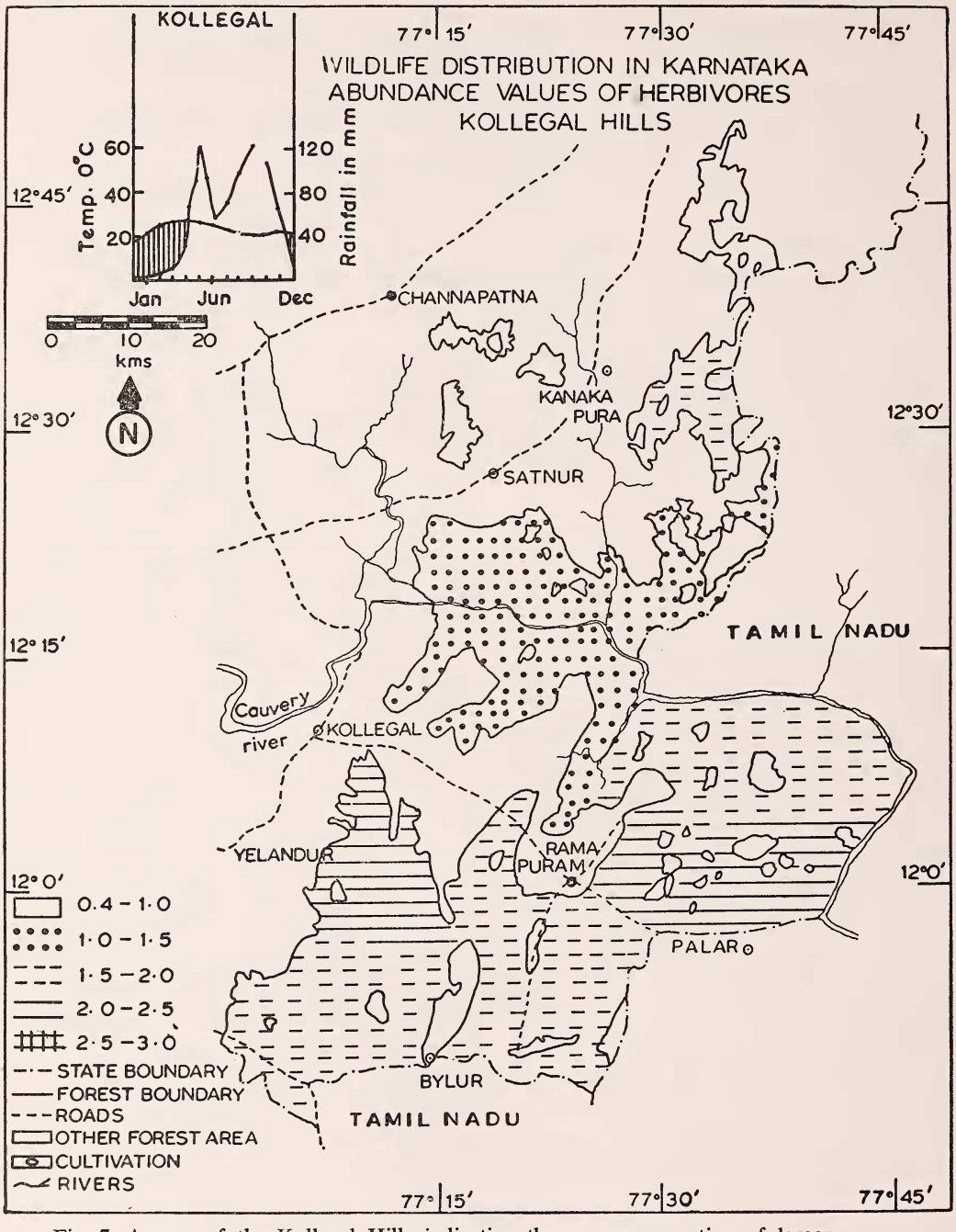


Fig. 7. A map of the Kollegal Hills indicating the occurrence rating of larger mammalian herbivores.

TABLE 1

ON THE DISTRIBUTION OF FOOD RESOURCES OF MAMMALIAN POPULATIONS IN DIFFERENT TYPES OF VEGETATION

	Grass	Herbs	Shrubs	Bamboo	Tree leaves	Woody matter	Fleshy fruits	Seeds	Tubers	Insects	Frogs & lizards
Evergreen											
Climax	O	R	R	O	A	A	A	R	R	A	A
Degraded	C	C	C	C	A	A	A	C	C	A	A
Shola and grassy downs	A	R	R	O	A	A	A	A	R	A	A
Deciduous											
Climax	R	C	C	C	A	A	A	A	C	A	A
Degraded	A	A	A	A	A	A	A	A	C	A	C
Scrub											
Climax	C	C	A	O	C	C	C	C	R	C	C
Degraded	C	C	C	O	R	R	R	C	R	C	C

O = absent, R = Rare, C = Common, A = Abundant.

TABLE 2

ON THE DEPENDENCE OF HERBIVOROUS OR OMNIVOROUS MAMMALS ON DIFFERENT FOOD RESOURCES

	Grass	Herbs	Shrubs	Bamboo	Tree leaves	Woody matter	Fleshy fruits	Seeds	Tubers	Insects	Frogs & lizards
Liontailed Macaque	R	O	O	O	R	O	A	R	O	C	O
Bonnet Macaque	O	R	R	C	O	R	C	C	O	C	R
Hanuman Langur	O	C	A	A	A	O	A	C	O	O	O
Giant Squirrel	O	O	O	O	R	C	A	A	O	C	O
Elephant	A	C	R	A	C	C	C	R	O	O	O
Gaur	A	R	C	C	R	O	C	O	O	O	O
Sambar	A	R	A	C	R	O	C	O	O	O	O
Chital	A	R	C	C	R	O	C	O	O	O	O
Barking Deer	A	R	R	C	R	O	C	O	O	O	O
Nilgai	A	R	C	C	R	O	O	O	O	O	O
Blackbuck	A	R	C	O	O	O	C	R	O	O	O
Chinkara	A	R	C	O	O	O	C	O	O	O	O
Nilgiri Tahr	A	R	O	O	O	O	O	O	O	O	O
Wild Pig	R	R	R	C	O	O	C	C	A	C	C
Blacknaped Hare	A	C	R	R	O	O	O	O	O	O	O
Porcupine	O	O	C	C	O	C	A	C	A	R	O
Other Rodents	R	R	R	C	R	C	C	A	A	A	O
Sloth Bear	O	O	O	O	O	O	A	R	A	A	R

O = absent, R = Rare, C = Common, A = Abundant.